

# Claims

- [c1] 1. A hybrid electric vehicle comprising:
- a vehicle frame;
  - a plurality of drive wheels connected to the frame;
  - an internal combustion engine connected to the frame that rotates in a single direction and selectively drives the wheels and provides engine compression braking torque at each drive wheel;
  - an integrated starter generator motor connected to the internal combustion engine that rotates in a same direction as the internal combustion engine, the integrated starter generator motor selectively starting the internal combustion engine for driving the wheels and providing braking torque at each drive wheel;
  - a powertrain control module that controls the operating parameters of the internal combustion engine and the integrated starter generator motor, the powertrain control module being selectively actuated by a vehicle operator by actuating an accelerator pedal for an accelerator torque request;
  - an electro-hydraulic brake system for vehicle braking, the electro-hydraulic brake system being selectively actuated by the vehicle operator by actuating a vehicle

brake pedal for a vehicle brake torque request;  
an electronic brake controller for controlling the electro-hydraulic brake torque applied to the wheels by the electro-hydraulic brake system;  
a vehicle rollback sensor for determining a vehicle rollback state, and,  
wherein the electronic brake controller actuates the electro-hydraulic brakes, instead of applying an engine compression braking torque and an integrated starter generator motor braking torque in a predetermined hill holding condition, where the vehicle rollback state exists, the vehicle brake torque request exists below a predetermined vehicle brake torque request level, the accelerator torque request exists below a predetermined accelerator torque request level, and the internal combustion engine is running.

[c2] 2. The hybrid electric vehicle as set forth in claim 1 wherein the powertrain control module turns off the internal combustion engine in the predetermined hill holding condition.

[c3] 3. The hybrid electric vehicle as set forth in claim 1, when a vehicle operator actuates the accelerator pedal for the accelerator torque request in the predetermined hill hold condition;  
where the powertrain control module turns on the inter-

nal combustion engine, engages a vehicle transmission, provides adaptive filtering during a clutch engagement; the electronic brake controller de-actuates the electro-hydraulic brakes; and the internal combustion engine provides the acceleration request.

[c4] 4. The hybrid electric vehicle as set forth in claim 1, during a vehicle creep condition; where the operator is not actuating the accelerator pedal and not actuating the vehicle brake pedal; the vehicle transmission is in a gear; the powertrain control module determines whether vehicle creep will be powered by the internal combustion engine, the integrated starter generator motor or both; and wherein the electronic brake controller will not actuate the electro-hydraulic brakes.

[c5] 5. The hybrid electric vehicle as set forth in claim 1 during a predetermined two footer condition, where the vehicle is on a grade and in a gear, the vehicle operator actuates the accelerator pedal for an accelerator torque request, the vehicle operator actuates the brake pedal for a brake torque request; wherein the magnitude of the brake torque request is greater than the accelerator torque request; and the electronic brake control system actuates the electro-

hydraulic brakes.

- [c6] 6. The hybrid electric vehicle as set forth in claim 5, wherein the powertrain control module turns off the internal combustion engine in the predetermined two footer condition.
- [c7] 7. A method of hill holding a hybrid electric vehicle comprising:
- measuring a vehicle rollback state using a vehicle rollback sensor and sending a vehicle rollback state output to a powertrain control module;
  - measuring a brake torque request with an electronic brake controller using a brake pedal sensor and sending a vehicle brake torque request output to the powertrain control module;
  - measuring an accelerator torque request using an accelerator pedal sensor and sending an accelerator torque request output to the powertrain control module;
  - determining an internal combustion engine running state using an engine sensor and sending an internal combustion engine running state output to the powertrain control module;
  - calculating the presence of a predetermined hill holding condition using the vehicle rollback state output, the vehicle brake torque request output, the accelerator torque request output, and the internal combustion engine run-

ning state output, and;  
actuating the transition of a set of electro-hydraulic brakes using the electronic brake controller in the pre-determined hill holding condition.

[c8] 8. The method as set forth in claim 7 further comprising turning off the internal combustion engine using the powertrain control module in the predetermined vehicle hill holding condition.

[c9] 9. The method as set forth in claim 8 further comprising, when a vehicle operator actuates the accelerator pedal requesting vehicle acceleration;  
de-actuating the transition of the electro-hydraulic brakes using the electronic brake controller;  
turning on the internal combustion engine using the powertrain control module; and  
accelerating the vehicle using the internal combustion engine providing the vehicle operator with the vehicle acceleration.

[c10] 10. A method as set forth in claim 7 further comprising:  
detecting a vehicle gear selection using the gear selection sensor and sending the gear selection output to the powertrain control module;  
calculating the presence of a two footer condition when the magnitude of the vehicle brake torque request out-

put is greater than the accelerator torque request output;  
and  
actuating the electro-hydraulic brakes using the electronic brake controller in the predetermined two footer condition.

[c11] 11. The method as set forth in claim 10 further comprising turning off the internal combustion engine using the powertrain control module in the predetermined two footer condition.

[c12] 12. The method as set forth in claim 10 including, when the vehicle operator actuates the accelerator pedal requesting vehicle acceleration;  
sensing a vehicle acceleration request by the vehicle operator using the accelerator pedal sensor;  
de-actuating the transition of the electro-hydraulic brakes using the electronic brake controller;  
turning on the internal combustion engine using the powertrain control module; and  
accelerating the vehicle using the internal combustion engine providing the vehicle operator with the vehicle acceleration requested.